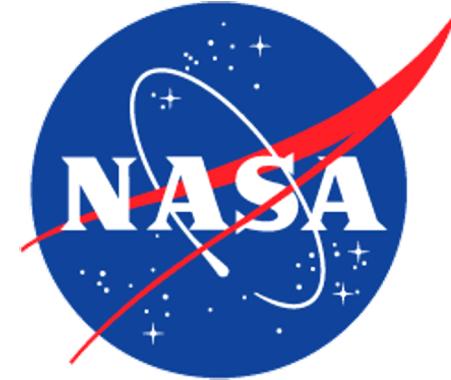# Hazard Perception & Avoidance (HPA) Overview

Presented to SC-147

February 8, 2022

- **Hazard Perception and Avoidance** (HPA) falls under Advanced Air Mobility's (AAM) Automated Flight and Contingency Management (AFCM) sub-project
  - Building on the work our lab did for NASA's UAS Integration into the NAS project
  - AFCM is tasked with looking at higher levels of automation for eVTOL aircraft

- Responsible for collecting data that can inform the development of a *tactical* avoidance system (e.g., traffic, terrain, obstacle & weather avoidance) for AAM
  - System is intended to support *UAM Maturity Level (UML) 4* operations
    - Medium complexity and medium density operations
    - Pilot may be either onboard or on the ground at UML-4, however AFCM is focused on **manned eVTOL operations**

- Using ACAS Xr as our research DAA/CA system in increasingly complex operations
  - Performing several part task and full mission sims, as well as flight tests, over next 4 years
  - Initial focus is on traffic avoidance, but work will expand to include terrain and obstacles

- **HPA Part Task Simulation 1**: data collection in February-March 2022
  - Integrating **ACAS Xr v1** into the fixed base eVTOL simulator in the HAT Lab at NASA Ames
  - Focus of the sim will be on automating the response to RAs and return to course
    - Will use low density & complexity operations
    - Will vary the number and type of scripted conflicts (DAA & CA encounters)
    - Ownship will be in cruise/forward flight for all encounters
    - Collecting feedback on acceptability of ACAS Xr alerting/guidance & automatic maneuvers

- **Assured Vehicle Automation (AVA) Simulation 1**: data collection July-September 2022
  - Integrating **ACAS Xr v2** into the Vertical Motion Simulator (VMS) at Ames
  - Focus will be on scripting conflicts both while en route and in & around the terminal area
    - Will include encounters while the eVTOL ownship is in transition to - and in - vertical flight
    - Plan to include terrain and obstacles to investigate presentation of Xr's terrain/obstacle avoidance capabilities
  - Will collect feedback on pilot responses to DAA speed guidance and horizontal and blended RA maneuvers, along with typical performance data

- **Integration of Automation Systems (IAS) Flight Test 1**: data collection April-July 2023
  - This flight test series is running in coordination with AAM's National Campaign flight test series
  - Integrating **ACAS Xr v2** onto helicopter (S-76) with onboard pilot and advanced automation capabilities
    - Examining DAA and RA alerting and guidance in different phases of flight
    - Including virtual terrain and obstacle data
    - Automating RA and return-to-course maneuvers

- **Simulations and Flight Tests Beyond 2023**
  - Increase level of integration between different technologies being developed under AAM and AFCM
    - E.g., the *strategic*-based Flight Path Management (FPM) system, the Expandable Variable Autonomy Architecture (EVAA), High Density Vertiport (HDV) technologies, and others
  - Airspace management technologies (e.g., PSUs, SDSPs) and airspace density/complexity will also increase with each study
  - Additional simulator studies planned for 2024
  - **IAS Flight Test 2** scheduled for Summer 2025

- Brief SC-147 & SC-228 on study plans and results
  - HPA is participating in SC-147's ACAS Xr Operations Working Group
  - Will incorporate key research questions identified by these groups into our work to extent possible

- The type of data we plan to collect and can provide to SC-147/228:
  - Characterize DAA response times with onboard pilot
  - Subjective feedback regarding utility of DAA alerting and guidance with onboard pilots
  - How to display Xr v2 speed DAA guidance
  - How to display Xr v2 terrain and obstacle information
  - Subjective feedback regarding effectiveness of auto-RA and auto-RTC presentation and implementation
  - Effectiveness of ACAS Xr alerting/guidance in different phases of flight/flight regimes